(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 4 098 460 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
29.05.2024 Bulletin 2024/22

(21) Application number: **22174132.5**

(22) Date of filing: **18.05.2022**

(51) International Patent Classification (IPC):
B60C 9/20 (2006.01) ***B60C 9/28*** (2006.01)
B60C 11/03 (2006.01)

(52) Cooperative Patent Classification (CPC):
B60C 9/2006; B60C 9/28; B60C 11/0306;
B60C 2009/2016; B60C 2009/2019;
B60C 2011/0341; B60C 2011/0348;
B60C 2011/0353; B60C 2011/0388; B60C 2200/06

(54) PNEUMATIC TIRE FOR HEAVY DUTY

LUFTREIFEN FÜR SCHWEREINSATZ

PNEU POUR USAGE INTENSIF

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **02.06.2021 JP 2021093162**

(43) Date of publication of application:
07.12.2022 Bulletin 2022/49

(73) Proprietor: **Sumitomo Rubber Industries, Ltd.**
Kobe-shi, Hyogo-ken 651-0072 (JP)

(72) Inventor: **LI, Qingmao**
Kobe-shi, 651-0072 (JP)

(74) Representative: **Manitz Finsterwald**
Patent- und Rechtsanwaltspartnerschaft mbB
Martin-Greif-Strasse 1
80336 München (DE)

(56) References cited:
EP-A1- 2 033 814 US-A- 3 556 190

Description

FIELD OF THE INVENTION

[0001] The present invention relates to a pneumatic tire for heavy duty.

BACKGROUND OF THE INVENITON

[0002] Conventionally, various tires for heavy duty having a small aspect ratio have been proposed. For example, Patent Document 1 shown below has proposed a pneumatic tire for heavy duty with a small aspect ratio of 65 or less as indicated. By specifying the positioning of shoulder circumferential grooves, a belt, and edge bands, this pneumatic tire for heavy duty is expected to improve uneven wear resistance performance while maintaining formability.

PRIOR ART

[Patent Document]

[0003] [Patent Document 1]
Japanese Unexamined Patent Application Publication No. 2020-152136;
EP 2 033 814 A1 discloses a pneumatic tire for heavy duty comprising the features according to the preamble of claim 1.
US 3 556 190 A discloses a pneumatic tire for heavy duty comprising features according to a related technology but including narrow circumferential grooves only which close under load.

SUMMARY OF THE INVENTION

[Problems to be solved by the Invention]

[0004] In general, pneumatic tires for heavy duty tend to grow in outer diameter due to degradation from use. In particular, pneumatic tires for heavy duty having an aspect ratio of 65% or less tend to have uneven wear in the tread portions due to a large difference in an amount of an outer diameter growth between areas near tread edges and an area near a tire equator of the tread portion. On the other hand, in the aforementioned pneumatic tires for heavy duty, attempts to improve the uneven wear resistance performance tend to sacrifice rolling resistance and wet performance.
[0005] The present invention was made in view of the above, and a primary object thereof is to provide a pneumatic tire for heavy duty having the aspect ratio of 65% or less capable of improving the uneven wear resistance performance without sacrificing the rolling resistance and the wet performance.

[Means for Solving the Problems]

[0006] The present invention is a pneumatic tire for heavy duty having an aspect ratio of 65% or less including:

a tread portion;
a pair of bead portions;
a carcass extending from one of the bead portions to the other one of the bead portions via the tread portion; and
a belt layer arranged inside the tread portion,

wherein

the tread portion includes a plurality of circumferential grooves extending continuously in a tire circumferential direction,
the circumferential grooves include a pair of shoulder circumferential grooves and at least one crown circumferential groove arranged between the shoulder circumferential grooves,
the crown circumferential groove is a narrow groove that closes when contacting the ground under a condition of being loaded with a maximum tire load,
each of the shoulder circumferential grooves is a wide groove that does not close when contacting the ground under the condition of being loaded with the maximum tire load,
the belt layer includes a plurality of belt cords made of metal and arranged obliquely with respect to the tire circumferential direction,
a pair of outer ends in a tire axial direction of the belt layer are each positioned axially outside a respective one of

the shoulder circumferential grooves,

a belt half width from a tire equator to one of the outer ends of the belt layer is 55% or more and 85% or less of a carcass half width, the carcass half width being a distance in the tire axial direction from the tire equator to the carcass at a maximum tire width position in an axial half of the tire.

[Effects of the Invention]

[0007] By adopting the above configuration, it is possible that the pneumatic tire for heavy duty of the present invention improves the uneven wear resistance performance without sacrificing the rolling resistance and the wet performance.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

FIG. 1 is a cross-sectional view of the pneumatic tire for heavy duty according to an embodiment of the present invention.

FIG. 2 is an enlarged view of the tread portion of FIG. 1.

FIG. 3 is an enlarged view of a part of one of sidewall portions and a half of the tread portion of FIG.1.

FIG. 4 is a plan view of the tread portion of FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

[0009] An embodiment of the present invention will now be described in conjunction with accompanying drawings. FIG. 1 is a tire meridian section passing through a tire rotational axis of a pneumatic tire for heavy duty (hereinafter, may be simply referred to as "tire") 1 in a standard state. The tire 1 of the present embodiment is used for a small truck, a bus, and the like, for example.

[0010] The above-mentioned "standard state" is a state in which the tire 1 is mounted on a standard rim (not shown), inflated to a standard inner pressure, and loaded with no tire load. In the case of tires for which various standards are not specified, the above-mentioned standard state means a state of standard use of the tire according to the intended purpose of use of the tire and being loaded with no tire load. In the present specification, unless otherwise noted, the dimensions and the like of various parts of the tire are values measured in the standard state. In the case of components inside the tire, dimensions and the like thereof refer to the dimensions in a state where the shape of the tire cross section is substantially the same as the shape of the tire in the standard state described above.

[0011] The "standard rim" is a wheel rim specified for the concerned tire by a standard included in a standardization system on which the tire is based, for example, the "normal wheel rim" in JATMA, "Design Rim" in TRA, and "Measuring Rim" in ETRTO.

[0012] The "standard inner pressure" is air pressure specified for the concerned tire by a standard included in a standardization system on which the tire is based, for example, the maximum air pressure in JATMA, maximum value listed in the "TIRE LOAD LIMITS AT VARIOUS COLD INFLATION PRESSURES" table in TRA, and "INFLATION PRESSURE" in ETRTO.

[0013] As shown in FIG. 1, the tire 1 has an aspect ratio of 65% or less. The aspect ratio is the ratio of a tire cross-sectional height (ht) to a tire cross-sectional width (Wt) in the standard state described above. It should be noted that if minute convex portions indicating patterns, letters, and the like are arranged on sidewall portions 3, the tire cross-sectional width (Wt) is measured excluding the aforementioned convex portions. Further, the tire cross-sectional height (ht) is the maximum height of the tire cross-section measured from a bead baseline BL. The bead baseline BL is a tire axial line passing through a rim diameter position of the rim on which the tire 1 is mounted.

[0014] The tire 1 includes a tread portion 2, the sidewall portions 3 arranged continuously to the tread portion 2 on both sides thereof in a tire axial direction, and bead portions 4 each arranged continuously to a respective one of the sidewall portions on an inner side in a tire radial direction.

[0015] FIG. 2 shows an enlarged cross-sectional view of the tread portion 2. As shown in FIG. 2, the tread portion 2 includes a plurality of circumferential grooves 10 extending continuously in a tire circumferential direction. The circumferential grooves 10 includes a pair of shoulder circumferential grooves 12 and at least one crown circumferential groove 11 provided between the pair of the shoulder circumferential grooves 12. In the present embodiment, two crown circumferential grooves 11 are provided between the pair of the shoulder circumferential grooves 12 so as to sandwich a tire equator (C).

[0016] The crown circumferential grooves 11 are each configured as a narrow groove that closes when contacting the ground under the condition of being loaded with a maximum tire load. On the other hand, each of the pair of the shoulder circumferential grooves 12 is configured as a wide groove that does not close when contacting the ground when the tire is mounted on a vehicle loaded with the maximum tire load. In the case of pneumatic tires for which various standards have been established, the above term "maximum tire load" means the maximum tire load specified for each tire by a standard included in a standardization system on which the tire is based, for example, the "maximum load capacity" in JATMA, maximum value listed in "TIRE LOAD LIMITS AT VARIOUS COLD INFLATION PRESSURES" table in TRA, and "LOAD CAPACITY" in ETRTO. In the case of tires for which the various standards are not specified, the maximum tire load means the maximum tire load under which the tire can continue to run.

[0017] As shown in FIG. 1, the tire 1 includes a carcass 6 and a belt layer 7 arranged inside the tread portion. The carcass 6 extends from one of the bead portions 4 to the other one of the bead portions 4 via one of the sidewall portions 3, the tread portion 2, and the other one of the sidewall portions 3.

[0018] The carcass 6 includes one carcass ply 6A, for example. The carcass 6 may be composed of a plurality of carcass ply 6A, for example. The carcass ply 6A consists of steel carcass cords arranged at an angle of 70 degrees or more and 90 degrees or less with respect to the tire circumferential direction, for example.

[0019] The carcass ply 6A has a main body portion (6a) and turned-up portions (6b). The main body portion (6a) extends between the pair of the bead portions 4. The turned portions (6b) are connected with the main body portion (6a) and each turned up from inside to outside in the tire axial direction around a respective one of bead cores 5.

[0020] The belt layer 7 is arranged radially outside the carcass 6 in the tread portion 2, for example. The belt layer 7 includes belt cords made of metal and arranged obliquely with respect to the tire circumferential direction. Further, a pair of axially outer ends of the belt layer are each positioned axially outside a respective one of the shoulder circumferential grooves 12.

[0021] FIG. 3 shows an enlarged view of a portion of one of the sidewall portions 3 and a half of the tread portion 2. As shown in FIG. 3, a belt half width W2 from the tire equator (C) to one of the outer ends of the belt layer 7 is 55% or more and 85% or less of a carcass half width W1. The carcass half width W1 is the distance in the tire axial direction from the tire equator (C) to the carcass 6 at a maximum tire width position in an axial half of the tire 1. By adopting the above configuration, it is possible that the uneven wear resistance performance is improved without sacrificing the rolling resistance and the wet performance. The reason for this is presumed to be the following mechanism.

[0022] Since the crown circumferential groove 11 is the above-mentioned narrow groove, the rigidity of the central portion of the tread portion 2 is maintained, therefore, it is possible that the increase in the rolling resistance is suppressed. On the other hand, since the shoulder circumferential grooves 12 are the above-mentioned wide grooves, the wet performance is ensured.

[0023] In general, pneumatic tires for heavy duty with an aspect ratio of 65% or less tend to have a large difference in the amount of the outer diameter growth due to degradation during running because of a large difference in a binding force of the belt layer 7 between the vicinities of the tread edges of the tread portion 2 and the vicinity of the tire equator. The belt half width W2 is specified to be 55% or more and 85% or less of the carcass half width W1, therefore, it is possible that the amount of the outer diameter growth of each part of the tread portion 2 is made uniform, thereby, it is possible that the uneven wear resistance performance is improved. It is considered that such a mechanism can improve the uneven wear resistance performance without sacrificing the rolling resistance and the wet performance.

[0024] A more detailed configuration of the present embodiment will now be described below. It should be noted that each of the configurations described below is a specific form of the present embodiment. Therefore, it goes without saying that the present invention can exert the above-described effects even if it does not have the configurations described below. Further, even if any one of the configurations described below is independently applied to the tire having the above-mentioned characteristics, improvement in performance according to each configuration can be expected. Furthermore, when some of the configurations described below are applied in combination, combined improvements in performance can be expected according to each of the applied configurations.

[0025] The belt half width W2 is preferably 60% or more, more preferably 65% or more, and preferably 80% or less, and more preferably 75% or less of the carcass half width W1. Thereby, it is possible that the uneven wear resistance performance is improved while the increase in the rolling resistance is suppressed.

[0026] The belt layer 7 incudes a plurality of belt plies overlaid in the tire radial direction. The belt layer 7 of the present embodiment includes a first belt ply 7A, a second belt ply 7B, a third belt ply 7C, and a fourth belt ply 7D layered in this order from inside to outside in the tire radial direction. In other words, the belt layer 7 in the present embodiment is composed of four belt plies. One belt ply includes a plurality of the belt cords arranged obliquely to the same side with respect to the tire circumferential direction, i.e., in each of the belt plies, the belt cords are arranged obliquely to the same side with respect to the tire circumferential direction. Further, at least one pair of the belt plies adjacent to each other in the tire radial direction are overlaid so that the belt cords of one of the belt plies intersect with the belt cords of the other one of the belt plies. It is possible that the belt layer 7 configured as such effectively reinforces the tread portion 2.

[0027] It is preferred that the belt cords included in the first belt ply 7A have an angle with respect to the tire circumferential direction larger than each of angles of the belt cords included in the second to fourth belt plies 7B to 7D with respect to the tire circumferential direction. The arrangement of the belt cords configured as such helps to reduce conicity and increase straight running stability.

[0028] The angle of the belt cords included in the first belt ply 7A with respect to the tire circumferential direction is preferably 40 degrees or more, more preferably 45 degrees or more, and preferably 60 degrees or less, more preferably 55 degrees or less.

[0029] The angles of the belt cords included in the second to fourth belt plies 7B to 7D with respect to the tire circumferential direction are each preferably 10 degrees or more, more preferably 12 degrees or more, and preferably 25 degrees or less, more preferably 22 degrees or less. It is possible that the second to fourth belt plies 7B to 7D configured as such exert an excellent tread reinforcing effect while maintaining the conicity small.

[0030] In the present embodiment, the outer ends of each of the first to fourth belt plies 7A to 7D are located axially outside the shoulder circumferential grooves 12. Further, at least the ply half widths from the tire equator to the ply outer ends in the tire axial direction of the second to fourth belt plies 7B to 7D are each 110% or more and 170% or less of a distance L1 (shown in FIG. 2) in the tire axial direction from the tire equator to a groove center of each of the shoulder circumferential grooves 12. In a preferred embodiment, the ply half width of the first belt ply 7A is also within the range described above. It is possible that the belt layer 7 including the belt plies configured as such reliably suppresses the outer diameter growth near the tread edges while suppressing the increase in the rolling resistance.

[0031] A first belt half width (Wa), which is the belt half width of the first belt ply 7A, is 65% or more and 80% or less of the carcass half width W1, for example. A second belt half width (Wb), which is the belt half width of the second belt ply 7B, is 75% or more and 85% or less of the carcass half width W1, for example. A third belt half width (Wc), which is the belt half width of the third belt ply 7C, is 65% or more and 80% or less of the carcass half width W1, for example. A fourth belt half width (Wd), which is the belt half width of the fourth belt ply 7D, is 50% or more and 70% or less of the carcass half width W1, for example. However, the present invention is not limited to such an embodiment.

[0032] As shown in FIG. 1, in the present embodiment, since the belt layer 7 has the above-described configuration, sufficient reinforcing effect is exerted, therefore, it is possible that the outer diameter growth of the tread portion 2 is surely suppressed. Therefore, the tread portion 2 in the present embodiment has only the belt layer 7 as a reinforcing member, and no other reinforcing members (e.g., a band layer having cords spirally wound, and the like) are provided therein. As a result, the weight increase of the tread portion 2 is suppressed, therefore, it is possible that the rolling resistance is maintained small.

[0033] As shown in FIG. 2, the distance L1 in the tire axial direction from the tire equator (C) to the groove center of each of the pair of shoulder circumferential grooves 12 is preferably 40% or more, more preferably 45% or more, and preferably 60% or less, more preferably 55% or less of the carcass half width W1 (shown in FIG. 3, and the same applies hereinafter). Therefore, it is possible that the shoulder circumferential grooves 12 exert excellent drainage performance.

[0034] The maximum groove width of each of the shoulder circumferential grooves 12 is, for example, 6.0 mm or more and 16.0 mm or less, preferably 8.0 mm or more and 14.0 mm or less. It is possible that the shoulder circumferential grooves 12 configured as such exert excellent drainage performance as wide grooves while suppressing an increase in the rolling resistance.

[0035] A distance L2 in the tire axial direction from the tire equator (C) to a groove center of each of the pair of the crown circumferential grooves 11 is preferably 10% or more and 20% or less of the carcass half width W1. As a result, it is possible that the wet performance is improved while uneven wear is suppressed in the central portion of the tread portion 2.

[0036] The maximum groove width of each of the crown circumferential grooves 11 is, for example, 1.0 mm or more and 3.0 mm or less, and preferably 1.5 mm or more and 2.5 mm or less. It is possible that the crown circumferential grooves 11 configured as such exert excellent drainage performance as narrow grooves while suppressing an increase in the rolling resistance.

[0037] FIG. 4 shows a plan view of the tread portion 2. As shown in FIG. 4, it is preferred that each of the shoulder circumferential grooves 12 and the crown circumferential grooves 11 extends in a zigzag manner. The shoulder circumferential grooves 12 and crown circumferential grooves 11 configured as such are helpful for improving traction performance during wet running.

[0038] In a more preferred embodiment, a minimum distance L3 in the tire axial direction between one of the shoulder circumferential grooves 12 extending in a zigzag manner and one of the crown circumferential grooves 11 adjacent thereto and extending in a zigzag manner is larger than a maximum distance L4 (shown in FIG. 2) between the adjacent outer ends of the belt plies included in the belt layer 7. Therefore, a sufficient distance is secured between each of the crown circumferential grooves 11 and one of the shoulder circumferential grooves 12 adj acent thereto, thereby, the uneven wear resistance performance is further improved.

[0039] Further, it is preferred that an amplitude amount in the tire axial direction of a groove center line of each of the crown circumferential grooves 11 in the tread plan view is smaller than a distance (d1) (shown in FIG. 2) in the tire radial direction from the bottom of each of the crown circumferential grooves 11 to the belt layer 7. Similarly, it is preferred that an amplitude amount in the tire axial direction of a groove center line of each of the shoulder circumferential grooves 12 in the tread plan view is larger than a distance (d2) (shown in FIG. 2) in the tire radial direction from the bottom of each of the shoulder circumferential grooves 12 to the belt layer 7. As a result, it is possible that the shoulder circumferential grooves 12 exert excellent drainage performance while suppressing the uneven wear around the crown circumferential grooves 11.

[0040] The tread portion 2 of the present embodiment is provided with only two shoulder circumferential grooves 12 and two crown circumferential grooves 11 and is not provided with other circumferential grooves. Therefore, the above-described effects are reliably exerted.

[0041] While detailed description has been made of the pneumatic tire for heavy duty according to an embodiment of the present invention, the present invention can be embodied in various forms within the scope of the appended claims.

[Examples]

[0042] Pneumatic tires for heavy duty of size 295/60R22.5 having the basic structure of FIG. 1 were made by way of test according to the specifications listed in Tables 1 and 2. As Reference 1, tires in which each of the crown circumferential grooves 11 was formed as a wide groove having the groove width of 10 mm were made by way of test. As References 2 and 3, tires having the belt half width outside the range specified according to the present invention were made by way of test. Each of the test tires has substantially the same configuration, except for the specifications given in Tables 1 and 2. Each of the test tires was tested for the rolling resistance, the wet performance, and the uneven wear resistance performance. Common specifications of the test tires and the test methods were as follows.

Tire mounting rim: 9.00x22.5
Tire inner pressure: 1000 kPa

< Rolling Resistance >

[0043] The rolling resistance of the test tires was measured while the test tires were run on a drum testing machine under a constant vertical load and at a constant speed. The results are indicated by an index based on the rolling resistance of Reference 1 being 100, wherein the smaller the numerical value, the smaller the rolling resistance is.

< Wet Performance >

[0044] The braking distance was measured when a test vehicle with the test tires mounted thereon entered a wet road surface at 60 km/h and braked suddenly. The results are indicated by an index based on the braking distance of Reference 1 being 100, wherein the smaller the numerical value, the better the wet performance is.

< Uneven Wear Resistance Performance >

[0045] The amount of wear on the tread was measured after a test vehicle with the test tires mounted thereon was driven for a certain distance in an urban area.
The results are indicated by an index based on Reference 1 being 100 for the difference between the amount of wear of the portion with the largest wear of the tread portion and the amount of wear of the portion with the least wear of the tread portion.
The smaller the numerical value, the better the uneven wear resistance performance is.

[0046] The test results are shown in Tables 1 and 2.

Table 1

		Ref. 1	Ref. 2	Ref. 3	Ex.1	Ex.2	Ex.3	Ex.4	Ex.5	Ex.6	Ex.7
Groove width of Crown circumferential groove	[mm]	10.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Groove width of Shoulder circumferential groove	[mm]	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Belt half width W2/ Carcass half width W1	[%]	79	50	90	79	55	60	65	70	75	85

(continued)

		Ref. 1	Ref. 2	Ref. 3	Ex.1	Ex.2	Ex.3	Ex.4	Ex.5	Ex.6	Ex.7
Distance L1 from Tire equator W1 to Shoulder circumferential groove/ Carcass half width	[%]	50	50	50	50	50	50	50	50	50	50
Rolling resistance	[index]	100	97	95	93	96	95	95	94	93	100
Wet performance	[index]	100	104	103	100	103	102	101	100	100	101
Uneven wear resistance performance	[index]	100	105	99	94	99	98	96	95	95	96

Table 2

		Ex.8	Ex.9	Ex.10	Ex.11	Ex.12	Ex. 13	Ex.14	Ex. 15
Groove width of Crown circumferential groove	[mm]	2.0	2.0	2.0	2.0	1.0	3.0	2.0	2.0
Groove width of Shoulder circumferential groove	[mm]	10.0	10.0	10.0	10.0	10.0	10.0	6.0	16.0
Belt half width W2/ Carcass half width W1	[%]	79	79	79	79	79	79	79	79
Distance L1 from Tire equator to Shoulder circumferential groove/ Carcass half width W1	[%]	40	45	55	60	50	50	50	50
Rolling resistance	[index]	96	95	93	91	93	93	93	93
Wet performance	[index]	100	100	100	102	100	100	100	100
Uneven wear resistance performance	[index]	97	96	94	94	94	94	94	94

[0047] From the test results, it was confirmed that the tires in Examples improved the uneven wear resistance performance without sacrificing the rolling resistance and the wet performance.

[Description of Reference Signs]

[0048]

2	tread portion
4	bead portion
6	carcass
7	belt layer
10	circumferential groove
11	crown circumferential groove
12	shoulder circumferential groove
W1	carcass half width
W2	belt half width

Claims

1. A pneumatic tire (1) for heavy duty having an aspect ratio of 65% or less comprising:

   a tread portion (2);
   a pair of bead portions (4);
   a carcass (6) extending from one of the bead portions (4) to the other one of the bead portions (4) via the tread portion (2); and
   a belt layer (7) arranged inside the tread portion (2),

   wherein

   the tread portion (2) includes a plurality of circumferential grooves (10) extending continuously in a tire circumferential direction,
   the circumferential grooves (10) include a pair of shoulder circumferential grooves (12) and at least one crown circumferential groove (11) arranged between the shoulder circumferential grooves (12),
   each of the shoulder circumferential grooves (12) is a wide groove that does not close when contacting the ground under the condition of being loaded with the maximum tire load,
   the belt layer (7) includes a plurality of belt cords made of metal and arranged obliquely with respect to the tire circumferential direction, and
   a pair of outer ends in a tire axial direction of the belt layer (7) are each positioned axially outside a respective one of the shoulder circumferential grooves (12),

   characterized in that

   the crown circumferential groove (12) is a narrow groove that closes when contacting the ground under a condition of being loaded with a maximum tire load when the tire (1) is mounted on a standard rim and inflated to a standard inner pressure, wherein the standard rim is a wheel rim specified for the tire (1) by a standard included in a standardization system on which the tire (1) is based, and the standard inner pressure is an air pressure specified for the tire (1) by a standard included in a standardization system on which the tire (1) is based, and wherein the maximum tire load is specified for the tire (1) by a standard included in a standardization system on which the tire (1) is based,
   and
   a belt half width (W2) from a tire equator (C) to one of the outer ends of the belt layer is 55% or more and 85% or less of a carcass half width (W1), the carcass half width (W1) being a distance in the tire axial direction from the tire equator (C) to the carcass (6) at a maximum tire width position in an axial half of the tire (1).

2. The pneumatic tire (1) for heavy duty according to claim 1, wherein a distance (L1) in the tire axial direction from the tire equator (C) to a groove center of each of the shoulder circumferential grooves (12) is 40% or more and 60% or less of the carcass half width (W1).

3. The pneumatic tire (1) for heavy duty according to claim 1 or 2, wherein two crown circumferential grooves (11) are provided between the shoulder circumferential grooves (12).

4. The pneumatic tire (1) for heavy duty according to any one of claims 1 to 3, wherein

   the belt layer (7) includes a plurality of belt plies (7A, 7B, 7C, 7D) overlaid in a tire radial direction,
   in each of the belt plies (7A, 7B, 7C, 7D), the belt cords are arranged obliquely to the same side with respect to the tire circumferential direction, and
   at least one pair of the belt plies (7A, 7B, 7C, 7D) adjacent to each other in the tire radial direction are overlaid so that the belt cords of one of the belt plies (7A, 7B, 7C, 7D) of the pair intersect with the belt cords of the other one of the belt plies (7A, 7B, 7C, 7D) of the pair.

5. The pneumatic tire (1) for heavy duty according to any one of claims 1 to 4, wherein

   the belt plies (7A, 7B, 7C, 7D) include a first belt ply (7A), a second belt ply (7B), a third belt ply (7C), and a fourth belt ply (7D) layered in this order from inside to outside in the tire radial direction, and
   the belt cords included in the first belt ply (7A) have an angle with respect to the tire circumferential direction

larger than each of angles of the belt cords included in the second to fourth belt plies (7B, 7C, 7D) with respect to the tire circumferential direction.

6. The pneumatic tire (1) for heavy duty according to claim 5, wherein the belt cords included in the second to fourth belt plies (7B, 7C, 7D) are arranged at the angle of 10 degrees or more and 25 degrees or less with respect to the tire circumferential direction.

7. The pneumatic tire (1) for heavy duty according to claim 5 or 6, wherein the belt cords included in the first belt ply (7A) are arranged at the angle of 40 degrees or more and 60 degrees or less with respect to the tire circumferential direction.

8. The pneumatic tire (1) for heavy duty according to any one of claims 5 to 7, wherein in each of the second to fourth belt plies (7B, 7C, 7D), a ply half width (Wb, Wc, Wd) from the tire equator (C) to each of ply outer ends in the tire axial direction is 110% or more and 170% or less of a distance (L1) in the tire axial direction from the tire equator (C) to a groove center of each of the shoulder circumferential grooves (12).

Patentansprüche

1. Luftreifen (1) für schwere Last, der ein Aspektverhältnis von 65 % oder weniger aufweist und umfasst:

   einen Laufflächenabschnitt (2);
   ein Paar von Wulstabschnitten (4);
   eine Karkasse (6), die sich von einem der Wulstabschnitte (4) über den Laufflächenabschnitt (2) bis zu dem anderen der Wulstabschnitte (4) streckt; und
   eine Gürtellage (7), die innerhalb des Laufflächenabschnitts (2) angeordnet ist,

   wobei

   der Laufflächenabschnitt (2) mehrere Umfangsrillen (10) aufweist, die sich kontinuierlich in einer Reifenumfangsrichtung erstrecken,
   die Umfangsrillen (10) ein Paar von Schulterumfangsrillen (12) und zumindest eine Kronenumfangsrille (11) umfassen, die zwischen den Schulterumfangsrillen (12) angeordnet ist,
   jede der Schulterumfangsrillen (12) eine breite Rille ist, die sich nicht schließt, wenn sie den Boden unter der Bedingung einer Belastung mit der maximalen Reifenlast berührt,
   die Gürtellage (7) mehrere Gürtelkorde aufweist, die aus Metall hergestellt sind und bezogen auf die Reifenumfangsrichtung schräg angeordnet sind, und
   ein Paar von äußeren Enden der Gürtellage (7) in einer Reifenaxialrichtung jeweils axial außerhalb einer jeweiligen der Schulterumfangsrillen (12) angeordnet sind,

   dadurch gekennzeichnet, dass

   die Kronenumfangsrille (12) eine enge Rille ist, die sich schließt, wenn sie den Boden unter einer Bedingung einer Belastung mit einer maximalen Reifenlast berührt, wenn der Reifen (1) an einer Standardfelge montiert und bis zu einem Standard-Innendruck aufgepumpt ist, wobei die Standardfelge eine Radfelge ist, die für den Reifen (1) durch einen Standard spezifiziert ist, der in einem Standardisierungssystem umfasst ist, auf welchem der Reifen (1) basiert, und der Standard-Innendruck ein Luftdruck ist, der für den Reifen (1) durch einen Standard spezifiziert ist, der in einem Standardisierungssystem umfasst ist, auf welchem der Reifen (1) basiert, und wobei die maximale Reifenlast für den Reifen (1) durch einen Standard spezifiziert ist, der in einem Standardisierungssystem umfasst ist, auf welchem der Reifen (1) basiert,
   und
   eine Gürtelhalbbreite (W2) von einem Reifenäquator (C) bis zu einem der äußeren Enden der Gürtellage 55 % oder mehr und 85 % oder weniger einer Karkassenhalbbreite (W1) beträgt, wobei die Karkassenhalbbreite (W1) eine Distanz in der Reifenaxialrichtung von dem Reifenäquator (C) bis zu der Karkasse (6) bei einer Position mit maximaler Reifenbreite in einer axialen Hälfte des Reifens (1) ist.

2. Luftreifen (1) für schwere Last nach Anspruch 1, wobei eine Distanz (L1) in der Reifenaxialrichtung von dem Reifenäquator (C) bis zu einer Rillenmitte jeder der Schulterumfangsrillen (12) 40 % oder mehr und 60 % oder weniger

der Karkassenhalbbreite (W1) beträgt.

3. Luftreifen (1) für schwere Last nach Anspruch 1 oder 2, wobei zwei Kronenumfangsrillen (11) zwischen den Schulterumfangsrillen (12) vorgesehen sind.

4. Luftreifen (1) für schwere Last nach einem der Ansprüche 1 bis 3, wobei

die Gürtellage (7) mehrere Gürtelschichten (7A, 7B, 7C, 7D) umfasst, die in einer Reifenradialrichtung überlagert sind,
in jeder der Gürtelschichten (7A, 7B, 7C, 7D) die Gürtelkorde bezogen auf die Reifenumfangsrichtung schräg zu derselben Seite angeordnet sind, und
zumindest ein Paar der Gürtelschichten (7A, 7B, 7C, 7D), das zueinander in der Reifenradialrichtung benachbart ist, derart überlagert ist, dass die Gürtelkorde einer der Gürtelschichten (7A, 7B, 7C, 7D) des Paares die Gürtelkorde des anderen der Gürtelschichten (7A, 7B, 7C, 7D) des Paares schneiden.

5. Luftreifen (1) für schwere Last nach einem der Ansprüche 1 bis 4, wobei

die Gürtelschichten (7A, 7B, 7C, 7D) eine erste Gürtelschicht (7A), eine zweite Gürtelschicht (7B), eine dritte Gürtelschicht (7C) und eine vierte Gürtelschicht (7D) umfassen, die in der Reifenradialrichtung in dieser Reihenfolge von innen nach außen geschichtet sind, und
die Gürtelkorde in der ersten Gürtelschicht (7A) einen Winkel bezogen auf die Reifenumfangsrichtung aufweisen, der größer als jeder von Winkeln der Gürtelkorde, die in der zweiten bis vierten Gürtelschicht (7B, 7C, 7D) umfasst sind, bezogen auf die Reifenumfangsrichtung ist.

6. Luftreifen (1) für schwere Last nach Anspruch 5, wobei die Gürtelkorde, die in der zweiten bis vierten Gürtelschicht (7B, 7C, 7D) umfasst sind, unter dem Winkel von 10 Grad oder mehr und von 25 Grad oder weniger bezogen auf die Reifenumfangsrichtung angeordnet sind.

7. Luftreifen (1) für schwere Last nach Anspruch 5 oder 6, wobei die Gürtelkorde, die in der ersten Gürtelschicht (7A) umfasst sind, unter dem Winkel von 40 Grad oder mehr und von 60 Grad oder weniger bezogen auf die Reifenumfangsrichtung angeordnet sind.

8. Luftreifen (1) für schwere Last nach einem der Ansprüche 5 bis 7, wobei in jeder der zweiten bis vierten Gürtelschicht (7B, 7C, 7D) eine Schichthalbbreite (Wb, Wc, Wd) von dem Reifenäquator (C) bis zu jedem von äußeren Enden der Schicht in der Reifenaxialrichtung 110 % oder mehr und 170 % oder weniger einer Distanz (L1) in der Reifenaxialrichtung von dem Reifenäquator (C) bis zu einer Rillenmitte jeder der Schulterumfangsrillen (12) beträgt.

Revendications

1. Bandage pneumatique (1) pour service intensif ayant un rapport d'aspect de 65 % ou moins, comprenant :

une portion formant bande de roulement (2) ;
une paire de portions de talon (4) ;
une carcasse (6) s'étendant depuis l'une des portions de talon (4) jusqu'à l'autre des portions de talon (4) via la portion formant bande de roulement (2) ; et
une couche de ceinture (7) agencée à l'intérieur de la portion formant bande de roulement (2),
dans lequel
la portion formant bande de roulement (2) inclut une pluralité de rainures circonférentielles (10) s'étendant en continu dans une direction circonférentielle du pneumatique,
les rainures circonférentielles (10) incluent une paire de rainures circonférentielles d'épaulement (12) et au moins une rainure circonférentielle de couronne (11) agencée entre les rainures circonférentielles d'épaulement (12),
chacune des rainures circonférentielles d'épaulement (12) est une rainure large qui ne se ferme pas quand elle est en contact avec le sol dans la condition dans laquelle elle est chargée avec la charge de pneumatique maximum,
la couche de ceinture (7) inclut une pluralité de câblés de ceinture faits en métal et agencés en oblique par rapport à la direction circonférentielle du pneumatique, et

une paire d'extrémités extérieures dans une direction axiale du pneumatique de la couche de ceinture (7) sont chacune positionnées axialement à l'extérieur d'une rainure respective des rainures circonférentielles d'épaulement (12),

caractérisé en ce que

la rainure circonférentielle de couronne (12) est une rainure étroite qui se ferme quand elle est en contact avec le sol dans une condition dans laquelle elle est chargée avec une charge de pneumatique maximum quand le pneumatique (1) est monté sur une jante standard et est gonflé à une pression interne standard, dans lequel la jante standard est une jante de roue spécifiée pour le pneumatique (1) par un standard inclus dans un système de standardisation sur lequel repose le pneumatique (1), et la pression interne standard est une pression d'air spécifiée pour le pneumatique (1) par un standard inclus dans un système de standardisation sur lequel repose le pneumatique (1), et dans lequel la charge de pneumatique maximum est spécifiée pour le pneumatique (1) par un standard inclus dans un système de standardisation sur lequel repose le pneumatique (1),

et

une demi-largeur de ceinture (W2) depuis un équateur de pneumatique (C) jusqu'à l'une des extrémités extérieures de la couche de ceinture est de 55 % ou plus et de 85 % ou moins d'une demi-largeur de carcasse (W1), la demi-largeur de carcasse (W1) étant une distance dans la direction axiale du pneumatique depuis l'équateur de pneumatique (C) jusqu'à la carcasse (6) à une position de largeur du pneumatique maximum dans une moitié axiale du pneumatique (1).

2. Bandage pneumatique (1) pour service intensif selon la revendication 1, dans lequel une distance (L1) dans la direction axiale du pneumatique depuis l'équateur de pneumatique (C) jusqu'à un centre de rainure de chacune des rainures circonférentielles d'épaulement (12) est de 40 % ou plus et de 60 % ou moins de la demi-largeur de carcasse (W1).

3. Bandage pneumatique (1) pour service intensif selon la revendication 1 ou 2, dans lequel deux rainures circonférentielles de couronne (11) sont prévues entre les rainures circonférentielles d'épaulement (12).

4. Bandage pneumatique (1) pour service intensif selon l'une quelconque des revendications 1 à 3, dans lequel

   la couche de ceinture (7) inclut une pluralité de nappes de ceinture (7A, 7B, 7C, 7D) superposées dans une direction radiale du pneumatique,

   dans chacune des nappes de ceinture (7A, 7B, 7C, 7D), les câblés de ceinture sont agencés en oblique vers le même côté par rapport à la direction circonférentielle du pneumatique, et

   au moins une paire des nappes de ceinture (7A, 7B, 7C, 7D) adjacentes l'une à l'autre dans la direction radiale du pneumatique sont superposées de telle sorte que les câblés de ceinture de l'une des nappes de ceinture (7A, 7B, 7C, 7D) de la paire se recoupent avec les câblés de ceinture de l'autre des nappes de ceinture (7A, 7B, 7C, 7D) de la paire.

5. Bandage pneumatique (1) pour service intensif selon l'une quelconque des revendications 1 à 4, dans lequel

   les nappes de ceinture (7A, 7B, 7C, 7D) incluent une première nappe de ceinture (7A), une deuxième nappe de ceinture (7B), une troisième nappe de ceinture (7C) et une quatrième nappe de ceinture (7D) posées en couches dans cet ordre depuis l'intérieur vers l'extérieur dans la direction radiale du pneumatique, et

   les câblés de ceinture inclus dans la première nappe de ceinture (7A) ont un angle par rapport à la direction circonférentielle du pneumatique plus grand que chacun des angles des câblés de ceinture inclus dans la deuxième, la troisième et la quatrième nappe de ceinture (7B, 7C, 7D) par rapport à la direction circonférentielle du pneumatique.

6. Bandage pneumatique (1) pour service intensif selon la revendication 5, dans lequel les câblés de ceinture inclus dans la deuxième, la troisième et la quatrième nappe de ceinture (7B, 7C, 7D) sont agencées sous l'angle de 10 degrés ou plus et de 25 degrés ou moins par rapport à la direction circonférentielle du pneumatique.

7. Bandage pneumatique (1) pour service intensif selon la revendication 5 ou 6, dans lequel les câblés de ceinture inclus dans la première nappe de ceinture (7A) sont agencés sous l'angle de 40 degrés ou plus et de 60 degrés ou moins par rapport à la direction circonférentielle du pneumatique.

8. Bandage pneumatique (1) pour service intensif selon l'une quelconque des revendications 5 à 7, dans lequel, dans chacune de la deuxième, de la troisième et de la quatrième nappe de ceinture (7B, 7C, 7D), une demi-largeur de

nappe (Wb, Wc, Wd) depuis l'équateur de pneumatique (C) jusqu'à chacune des extrémités extérieures de nappe dans la direction axiale du pneumatique est de 110 % ou plus et de 170 % ou moins d'une distance (L1) dans la direction axiale du pneumatique depuis l'équateur de pneumatique (C) jusqu'à un centre de rainure de chacune des rainures circonférentielles d'épaulement (12).

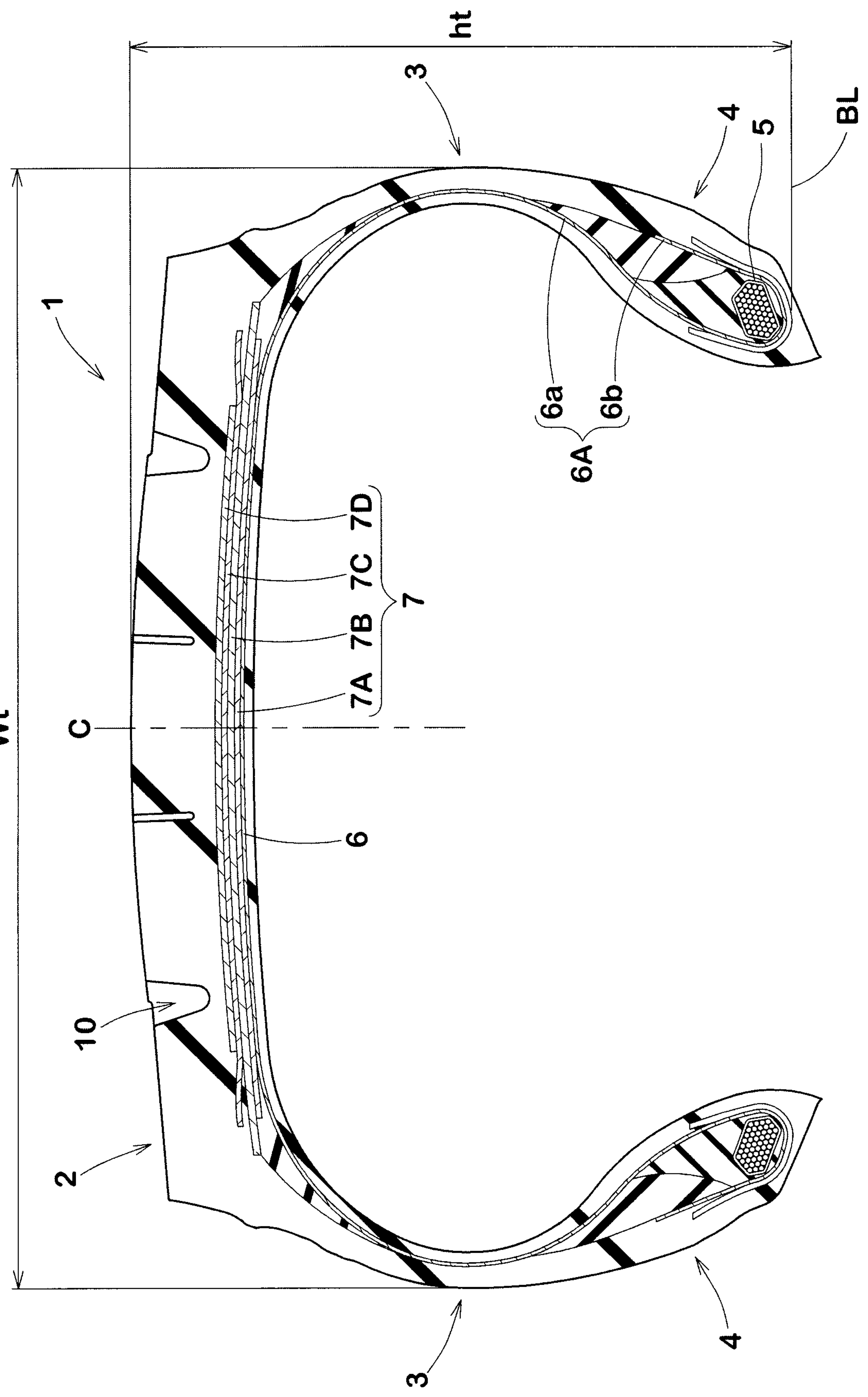


FIG.1

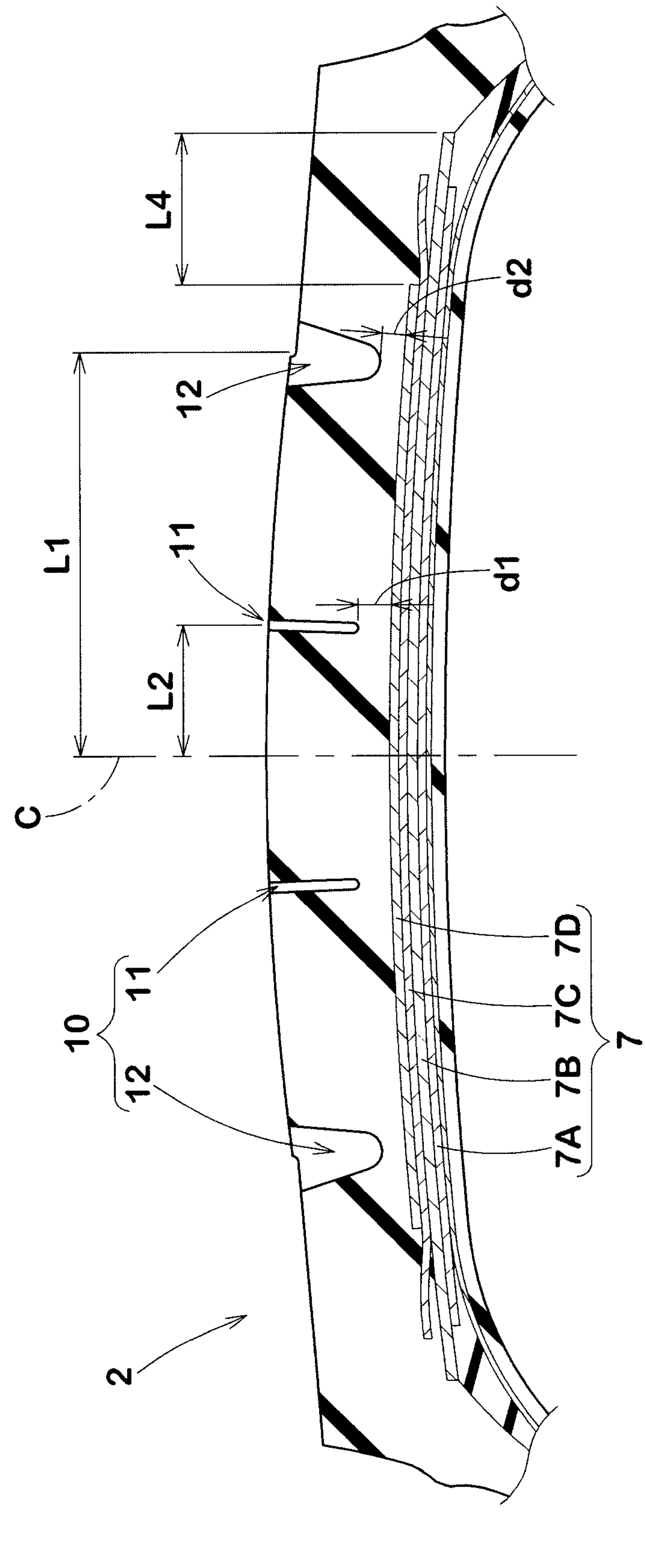


FIG.2

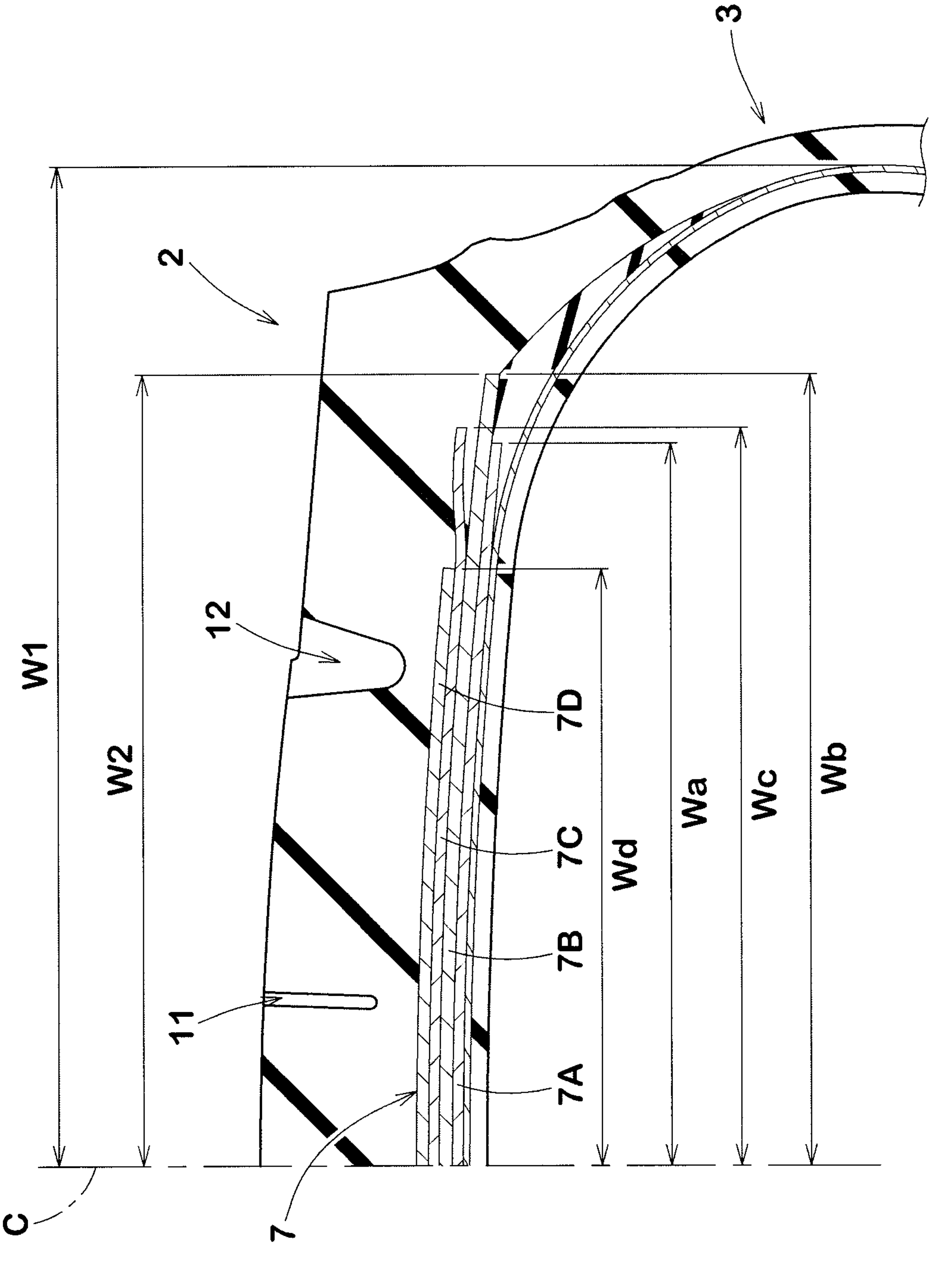
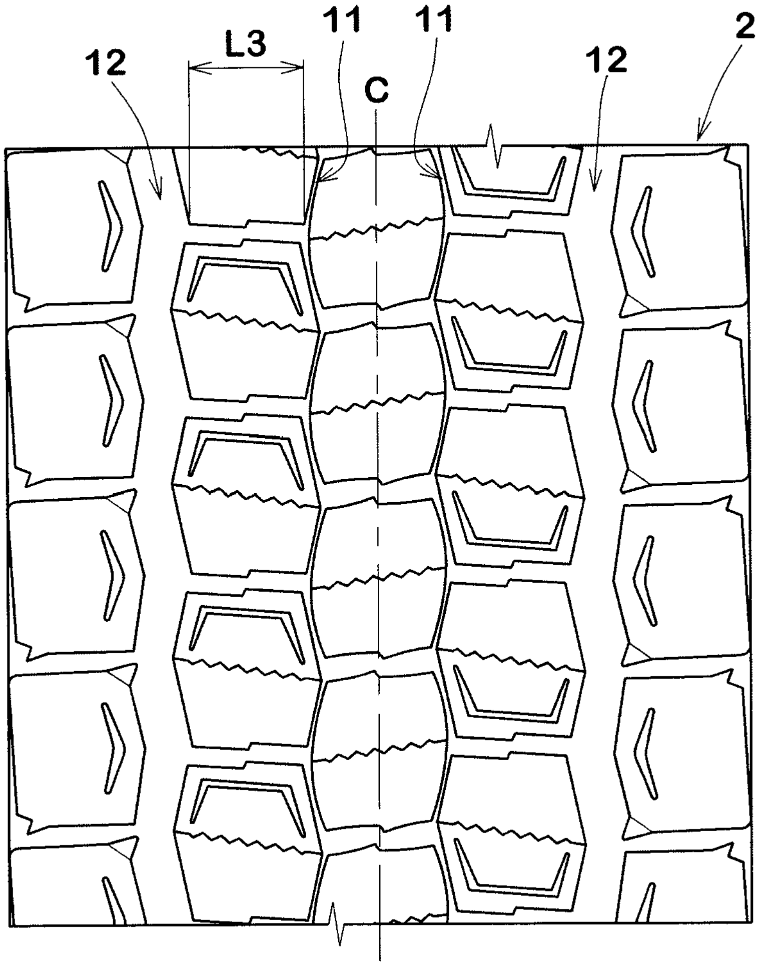


FIG.3

FIG.4



REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- JP 2020152136 A **[0003]**
- EP 2033814 A1 **[0003]**
- US 3556190 A **[0003]**